SUGGESTIONS FOR PROTECTION OF ORCHARD AND SHADE TREES FROM DAMAGE BY THE JAPANESE BEETLE

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The Japanese beetle is a brightly colored insect, broadly oval in general shape, and about three-eighths of an inch long. In color it is a brilliant metallic green, except for the greater part of the wing covers, which are reddish bronze. On the sides and tip of the abdomen are 12 tufts of hairs which resemble small white dots.

Nature of the injury

The Japanese beetle has chewing mouth parts. In general, it consumes the tissue between the veins of the leaves and also eats portions of the blossoms and of the fruit. The leaves are skeletonized wholly or in part, and the remnants of these leaves soon turn brown and fall. The beetle prefers to feed on portions of the plant exposed to the direct rays of the sun. It usually begins to feed on the upper and outer portions and works downward and inward. When the infestation is severe, even large fruit and shade trees may be completely defoliated within a few days. In the case of fruit trees, a partial second crop of leaves may be produced after feeding of the beetle has ceased. When this occurs, however, the likelihood of winter injury to the twigs is greatly increased, and the tree usually bears no fruit the following year. Repeated annual defoliation of shade and orchard trees weakens them to an appreciable extent and ultimately may cause death.

Of the susceptible fruits, those that ripen in the early summer are most subject to attack. Very little feeding--only a few punctures in the skin--is sufficient to destroy the market value of the fruit, but at times beetles gather on ripening apples and peaches in such large numbers as to cover the fruit completely and ruin it. The riper fruit is attacked first by the beetles, and when the infestation is relatively light the damage may be confined to these riper fruits.

Method of protecting plants

It is possible to protect the foliage and fruit of many of these plants by maintaining a deposit of spray residue on all portions of the plants subject to attack, during the period when the beetles are flying. The spray residue largely repels the beetle and prevents extensive feeding, the protection being obtained primarily by making the plant nonattractive rather than by poisoning the beetle.

Diseased and poorly nourished plants are more susceptible to attack than those in a healthy condition. It is practically impossible to prevent the beetles from becoming established in orchards where brown rot and similar diseases are present. Orchards should be protected from plant diseases and insect pests other than the Japanese beetle by the regular spraying recommended for the various locations.

Timeliness and thoroughness in the application of the repellent sprays are very important. As a general rule, and especially in localities where the beetles are very numerous, the first sprays should be applied when the beetles begin to appear in the vicinity, before they become established on the plants. In localities where the infestation is not so dense, the first application may be delayed until the beetles begin to appear on the plants to be protected. However, if, in the heavily infested localities, the spraying is delayed until beetles appear on the plants, it is often difficult to prevent injury. In Burlington County, N. J., the first application should be made the latter part of June; it should be made somewhat earlier in localities farther south and somewhat later in localities farther north than Burlington County.

To obtain satisfactory protection, all portions of the plants must be kept covered with the spray, as any unprotected portion of the foliage, blossom, or fruit will be selected by the beetle for attack. The spraying must be more thorough than is sometimes done for the control of other orchard and shade tree pests. If heavy rains occur after the application, it may be necessary to repeat the spray.

To apply the sprays properly to fruit and shade trees, and to high ornamental shrubs, power-spraying equipment is necessary. The high-pressure equipment in general use for the control of other insects and diseases has been employed with satisfactory results.

Recommendations for different plants

The sprays recommended in this circular have been tested for several years and have been found to be the most satisfactory for protecting the plants in connection with which they are mentioned. All of the sprays leave some residue on the fruit at the time of harvest. Any visible spray deposit should be removed from the fruit by suitable washing or wiping equipment, as it may interfere with marketing. If a spray containing a poison has been used, this removal of any deposit must be particularly thorough.

Early apples

Excellent protection is afforded to the foliage of early ripening apples by spraying with 3 pounds of aluminum sulphate and 20 pounds of hydrated lime to 100 gallons of water. In preparing this spray, the aluminum sulphate is dissolved in 2 gallons of water and a thin paste is made of the lime. The aluminum sulphate solution is added to the spray tank with the agitator running, and followed by the thin paste of hydrated lime.

Two or three applications of this combination may be necessary to secure adequate protection to the foliage, depending upon the density of the beetle population in the vicinity of the orchard. The second application should follow the first after an interval of 7 to 10 days, the third being made just before the height of the beetle season.

Fruit of early ripening apples can be protected by this spray only when the most careful orchard sanitation is practiced. Prematurely ripening or diseased fruit should be removed from the trees, as such fruit is attacked by the beetles even when thoroughly coated by the spray residue. Such fruit will cause sprayed trees to become infested. When these apples are consumed, the beetles begin to feed on the sound fruit. All apples on the ground should also be removed, as the odor of this fruit attracts beetles to the trees under which they are lying.

There will generally be some residue left on the fruit at the time of harvest. Although this material is nontoxic, it should be removed by the usual commercial wiping or washing equipment.

Late apples

Late apples can be protected by spraying with the lime-aluminum sulphate combination or with 6 pounds of acid lead arsenate, to which is added a suitable sticker, in 100 gallons of water. The use of 4 pounds of wheat flour to each 6 pounds of lead arsenate has been found to be one of the most satisfactory ways of increasing the adherence of lead arsenate to fruit and foliage. However, if other stickers or spreaders, such as cold-water-soluble powdered skim milk or a safe summer oil, have been used previously in the spray schedule, these materials may be substituted for the flour. Two pounds of powdered skim milk should be used to 6 pounds of lead arsenate. When oil is used enough should be added to give the diluted spray an oil content of from 0.5 to 0.6 percent. The use of summer oil emulsion with lead arsenate later than July 1st may cause difficulty at harvest time in removing the residue, and this combination should be used only by growers with effective washing machinery available for residue removal. When an application of lead arsenate is made for the control of the codling moth at the time when the spray for the Japanese beetle would normally be applied, the latter may not be necessary, but it may be necessary to make 1 or 2 additional applications of these sprays to give adequate protection throughout the season.

Since the question of residue on the fruit is not a factor with nonbearing apple trees, other stickers may be substituted for the flour when young stock is to be sprayed. Satisfactory results have been obtained by replacing the flour with 1-1/2 pints of light-pressed fish oil with a saponification value of 190 to 198, a specific gravity of 0.927 to 0.933 at 59° F., and iodine number of 139 to 193, and free-fatty-acid content of less than 5 percent. The oil should be added after the lead arsenate is in suspension in the water. One application usually gives protection for the season in areas of moderate infestation; two applications generally are necessary in the heavily infested areas.

Early peaches

Peaches which ripen during July can be protected by spraying with 5 pounds of derris, containing 4 percent rotenone, and 3 pounds of rosin residue emulsion in 100 gallons of water, providing the orchard sanitation suggested under "Early apples" is practiced. Rosin residue is the sticky resinous material which remains in the stills after the distillation of rosin. It is available on the market in three grades. The physical constants of the grade most satisfactory for use as a sticker for derris are as follows:

Melting point	30° C.
Specific gravity at 25° C.	1.03
Viscosity, Saybolt 100° C.	100 - 200 seconds
Acid number	50 - 75
Saponification number	89
Unsaponifiable	50 percent
Petroleum ether soluble	3.8 percent
Volatile with steam at 230° C.	25 - 35 percent

A 50 percent emulsion of rosin residue is prepared as follows: 4 pounds of casein are dispersed in about 45 pounds of water to which 12 ounces of ammonium hydroxide (sp. gr. 0.90) had been added; 50 pounds of rosin residue are added slowly with violent agitation and the agitation continued until the material becomes emulsified. This emulsion can be diluted without difficulty with hard cold water. In preparing this spray, the rosin residue emulsion is added to the water in the spray tank; then a thin paste of the derris is poured into the mixture.

The first application of the spray should be made when the beetles first appear in the orchard. Subsequent applications should follow at intervals of 7 to 10 days, the number necessary being dependent upon the degree of infestation in the vicinity.

Late peaches

The fruit of varieties ripening at the same time or later than Hiley is very seldom eaten by the beetle, but the foliage of late-ripening varieties is often severely injured and, unless protected, the fruit may be of poor quality. The foliage on these varieties and on young trees that have not come into bearing can be protected by the lime-aluminum sulphate spray. Because of the objectionable residue left by this spray, not more than two applications should be made. Under no circumstances should the trees be sprayed after July 15, as considerable residue will be on the fruit at the time of harvest.

Plums

The derris-rosin residue emulsion spray is recommended for early ripening varieties, and the hydrated lime-aluminum sulphate spray for the late varieties.

Cherries

The cherry crop is usually harvested before the Japanese beetle appears in sufficient numbers to cause damage to the foliage or fruit. After the fruit is harvested, an application of 6 pounds of lead arsenate and 4 pounds of flour in 100 gallons of water is recommended for the protection of the foliage. When leaf spot or yellow leaf is presented in the orchard, 2-1/2 gallons of commercial lime-sulphur solution should be added to the mixture. It may be necessary to repeat the application 2 or 3 weeks later.

Grapes

Bearing and nonbearing grapevines can be protected by spraying thoroughly with 6 pounds of lead arsenate and 4 pounds of flour in 100 gallons of water, or with 20 pounds of hydrated lime and 3 pounds of aluminum sulphate in 100 gallons of water. The Japanese beetle does not feed on the fruit. The spray should be directed downward from above to avoid excessive residue on the fruit at the time of harvest, but every leaf should be covered. Where it is the practice to use 8-12-100 bordeaux mixture (copper sulphate, 8 pounds; hydrated lime, 12 pounds; water, 100 gallons) on the grapes about the latter part of June, lead arsenate without the flour may be added. Additional applications of these sprays are usually necessary to protect the new growth that develops after the first application.

Small fruits

As there is no satisfactory procedure for removing the spray residue from raspberries, blackberries, and blueberries without causing damage to the fruit, the bushes should not be sprayed until after the crop is harvested. The lead arsenate and flour, or the lime-aluminum sulphate mixture may then be applied to protect the foliage.

Shade trees

The foliage of shade trees that are subject to attack by the Japanese beetle can be protected by spraying with 6 pounds of acid lead arsenate and 4 pounds of wheat flour in 100 gallons of water, or with 6 pounds of acid lead arsenate and 1-1/2 pints of light-pressed fish oil in 100 gallons of water. The lead arsenate spray being a stomach poison may be of additional value in controlling other leaf-feeding insects, but sometimes it is objectionable when applied in close proximity to residences. In such cases, the lime and aluminum sulphate mixture is recommended. These spray residues adhere well to the foliage, but it may be necessary to make a second application 2 or 3 weeks later after the initial treatment.